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SEWAGE POLLUTION OF BOUNDARY WATERS

By Allan J. McLaughlin, M.D.[1]

In December, 1910, the writer was directed by the Surgeon-General of the Public Health Service to investigate the sewage pollution of interstate and international waters, with special reference to the spread of typhoid fever.

In 1911, he completed a sanitary survey of the entire watershed of the Great Lakes on the United States side of the boundary.[2]

Briefly the conditions found were as follows:

An excessive prevalence of typhoid fever especially in the winter and spring months, punctuated at intervals by explosive epidemics. This excessive prevalence of typhoid fever especially in the winter and spring months was due in greatest measure to the unrestricted discharge of sewage into interstate and international waters used as sources of public water supplies. Disaster followed the use of this sewage polluted water for one of two reasons, either a failure to purify or the inefficiency of the attempted purification.

The delusion that water from the Great Lakes or their connecting rivers needs no purification has been cherished for years in our cities and even with our disgraceful record of waterborne typhoid and the lessons of numerous disastrous epidemics, it is still no easy task to convince municipal officials that purification of these waters is necessary.

The remedies suggested by the writer at that time were:

1. Safe water supplies, that is, water shown to be safe by daily bacteriologic examination.
2. Supervision and control of water supplies by the state to ensure efficiency and a safe effluent at all times.
3. Control of sewage discharge within permissible limits to prevent an unreasonable burden or responsibility upon filter plants.

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[1] Surgeon, U. S. Public Health Service, Chief Sanitary Expert and Director of Field Work for the International Joint Commission.

[2] McLaughlin, Allan J., Sewage Pollution of Interstate and International Waters. Hygiene Laboratory Bulletins 77, 83, and 89, Treasury Department, Washington, D. C.

4. Prevention of pollution from vessels.

In order to secure efficient and uniform results from the application of these remedies, he recommended that two sets of standards for water be formulated.

1. Standards for filtered or treated water.
2. Standards for raw water at the intakes.

In accordance with this recommendation in January, 1913, the Surgeon-General appointed a Commission for the Determination of a Standard of Purity for Drinking Water, and the report of that Commission will soon be published. This report will furnish us with a minimum standard to which all common carriers, trains and vessels must conform to prevent the spread of disease in interstate traffic. This furnishes the first standard recommended. The fixing of the second standard or standard for raw water at the water works intakes is a much more complex problem. However, great strides have been made in this direction also.

A committee of the National Association for the Prevention of Pollution of Rivers and Waterways,[3] made up of Geo. C. Whipple, Edward Bartow, Geo. M. Wisner, H. W. Clark, and the writer studied the problem of standards in a general way and agreed upon certain fundamental principles which made a very good starting point for more intensive studies. This brings us to the work of the International Joint Commission.

The term Commission is misleading as this body is in reality a tribunal formed under the treaty of January 11, 1909, between Great Britain and the United States to prevent disputes regarding the use of the boundary waters and to settle questions now pending or which may arise hereafter between the United States and Canada, involving the rights, obligations or interests of either in relation to the other or the inhabitants of the other along their common frontier. In addition to their judicial powers the Commission under Article IX of the treaty is empowered to investigate and report upon such questions as may be referred to it by the two governments. It is provided that such reports under Article IX shall not be regarded as decisions of the questions and shall in no way have the character of an arbitral award under this investigative function.

The question of pollution of boundary waters was referred to the Commission by the two governments. The reference was in two sections, the first dealing with the location, origin and extent of pollution and the second dealing with remedies. The text of the reference was as follows:

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[3] Pollution of Rivers and Waterways, Senate Document 235, 63d Congress, Washington, D. C., 1913.

> 1. To what extent and by what causes and in what localities have the boundary waters between the United States and Canada been polluted so as to be injurious to the public health and unfit for domestic or other uses?
>
> 2. In what way or manner, whether by the construction and operation of suitable drainage canals or plants at convenient points or otherwise, is it possible and advisable to remedy or prevent the pollution of these waters, and by what means or arrangement can the proper construction or operation of remedial or preventive works, or a system or method of rendering these waters sanitary and suitable for domestic and other uses, be best secured and maintained in order to insure the adequate protection and development of all interests involved on both sides of the boundary, and to fulfill the obligations undertaken in Article IV of the waterways treaty of January 11, 1909, between the United States and Great Britain, in which it is agreed that the waters therein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other?

The Commission took up first the question of location, origin and extent of pollution. At the Detroit session February 20, 1913, the writer was placed in charge of the investigation as chief sanitary expert and director of field work. Associated with him on the Canadian side were Dr. John W. S. McCullough, Chief Health Officer of Ontario and Dr. John A. Amyot, Professor of Hygiene, University of Toronto. Canadian laboratories were established at Fort Frances, Port Arthur, Sault Ste. Marie, Sarnia, Windsor, Amherstburg, Port Stanley, Fort Erie, Niagara-on-the-Lake and Kingston, Ontario, and Montreal. American laboratories were established at Port Huron, Michigan, Detroit, Michigan; on U. S. Revenue Cutter *Morrill*; Buffalo, New York; Youngstown, New York; Clayton, New York; and Van Buren, Maine.

In the interest of economy and efficiency it was deemed wise to utilize such established governmental agencies as might be available for the field investigation. Accordingly the coöperation of the United States Public Health Service, the Provincial Boards of Health of Ontario and Quebec, the State Board of Health of Michigan, and the Department of Health of the State of New York was secured and was of very great value to the Commission in carrying out the work.

The work extended from the Lake of the Woods through the entire chain of the Great Lakes and St. Lawrence River to the St. Johns

River on the Maine—New Brunswick border. Field work began in April and terminated November 1. There were over 1400 sampling points and over 19,000 samples taken and examined bacteriologically. The report presents as indices of pollution the average number of the colon bacillus per 100 cc. of water and the number of bacteria per cubic centimeter of water. The results of the investigation are shown by averages in concise form for each sampling point and cross-section by tables and colored maps. In addition diagrammatic representation is employed to show the degree of intensity of the area of pollution in each section of the boundary waters. In certain localities on the Great Lakes and in all their connecting waters dangerous sewage pollution was shown to exist, but the bulk of the Great Lakes waters remains in its pristine purity. The investigation shows that the colon bacillus is practically never present in unpolluted waters, and that the normal bacterial content of Great Lakes water is less than 10 per cubic centimeter. Great Lakes water is classified tentatively into five classes in this report, from the relatively pure water through slight, moderate, serious to gross pollution. The sources of pollution in the order of their importance are sewage from cities, sewage from vessels navigating these boundary waters, and the inevitable pollution following rains and thaws. The distance pollution may travel in the Lakes was demonstrated also. At the mouth of the Detroit River and at the mouth of the Niagara River serious pollution extends normally more than 10 miles into the lakes and on occasion was found 16 to 18 miles from shore. The distances from the cities of pure water in the lakes, the enormous cost of long pipe lines, coupled with the engineering difficulties in placing intakes beyond a 70-foot depth, make it impracticable in most instances to secure pure water from the lakes without treatment. The present position of intakes is such that there is not a single municipality using lake water which can be said to possess a safe water supply without treatment.

As might be expected the areas most grossly polluted are in the connecting rivers upon which large cities are situated. The pollution from vessels renders the St. Mary's River above the cities of Sault Ste. Marie unfit as a source of water supply without treatment, and vessel pollution combined with the sewage from the cities of Sault Ste. Marie cause gross pollution of the St. Mary's River from the Sault to Neebish Island.

Because of sewage pollution there is no point in the St. Clair River from which a safe water supply could be secured without treatment.

The Detroit River is polluted from Lake St. Clair to Sandwich sufficiently to make the water an unsafe source of water supply. From below Sandwich to its mouth the Detroit River is grossly polluted from shore to shore.

Gross pollution in the Niagara River extends along the American shore from Buffalo to Strawberry Island, throughout the entire Tonawanda Channel, and below the Falls gross pollution extends from shore to shore throughout the entire river and for miles out in Lake Ontario.

Investigation of the St. Lawrence River (Lake of the Thousand Islands) was made at two distinct seasons. The results obtained in April showed a slight degree of pollution. The results obtained in August showed a greatly increased pollution obviously due to the increase in summer resort population and to the sewage discharged from vessels.

The report of the field work gives an accurate survey of the origin, location and extent of pollution and completes the first half of the reference. The Commission is about to take up the second half of the reference which relates to remedies for pollution.

The writer's suggestion to the Commission in regard to proceeding with the second part of the reference consisted of three steps.

1. Secure the opinions of the most eminent sanitary engineers by submitting a list of questions. These opinions would form a sound basis for formulating a general policy and possibly some general minimum requirement.
2. Public hearings at which the municipalities could present their cases including expert engineering testimony, plans and projects.
3. Employment of expert sanitary engineers for the formulation of special standards for each waterway in excess of general minimum requirements depending upon local conditions and necessities.

It is probable that the Commission will proceed somewhat according to this outline. In so doing and in carrying out the third step, formulation of special standards, we will realize the second of the essentials which are necessary for the protection of the public health, viz: A standard for the raw water at the intakes.

The standard for raw water at the intakes in each locality seems to be the only means by which an equitable adjustment can be secured between the two agencies in producing safe water, viz: water purification and sewage treatment.

The writer is very glad to have the honor and opportunity of presenting this paper on sewage pollution of boundary waters to the American Water Works Association because of the special interest which this subject has for cities in the basin of the Great Lakes and the general interest which it must excite because of kindred problems in other watersheds. The writer cannot resist the temptation to avail himself of this opportunity to accentuate the necessity for safe water supplies. Time will not permit him to dwell at length upon certain cardinal necessities in the purveying of water to the public but he asks your permission to at least enumerate these points for your consideration.

The writer is glad to say that water works men generally appreciate that their duty obliges them to furnish not only sufficient water and clear water but most important of all safe water. It also gives him much pleasure to state that as a rule the water works engineers and superintendents of today are quite as much interested in the securing of a safe effluent as in utilizing the greatest amount of heat from their fuel or any other of their mechanical problems. Now what is a safe water? A safe water is one which is by daily bacteriologic examination shown to be free from pathogenic or intestinal organisms.

There has been entirely too much confidence in untreated surface supplies. Remember that a surface supply from an inhabited watershed is rarely safe without treatment and can only be said to be safe when daily bacteriologic examination shows it to be free from pathogenic or intestinal germs. To ensure safe water bacteriologic control is just as much a necessity for water purification plants as for untreated supplies. With a polluted source the mere installation of a purification plant does not guarantee safe water. Even if perfect in design and construction unless efficiently operated and controlled a safe effluent need not be expected. The writer has seen filter plants designed by our best engineers—perfect mechanisms which if properly operated would produce safe water—placed in the hands of an assassin who was a promoted stoker and absolutely ignorant of bacteriology or chemistry.

There is another point the writer desires to make and this refers to the adjustment of the balance between water purification and sewage treatment. He has seen very good filter plants struggling with a raw water which imposed an unreasonable responsibility upon the plant. A safe effluent under such conditions was secured at the price of eternal vigilance. Now, filter plants are not infallible and their operators even when skilled are only human. The writer believes a decent raw water should be made available for all plants and where necessary treatment of sewage should be carried at least far enough to secure this result.

The greatest obstacle to proper operation and control of plants has been the difficulty of securing the right man to place in charge of the plant. The best type of man for this position is a graduate in sanitary engineering. He will not only be conversant with the mechanical details of the plant, but will be able to adjust his chemicals according to the constituents and needs of the raw water. Most important of all, he will be able to make daily bacteriological examinations to determine the efficiency of purification. Nearly all the disasters due to sewage polluted water supplies which have occurred were due to lack of daily bacteriological knowledge of the public supply or the inefficient operation of plants by unskilled men. The writer believes the employment of such a graduate is economy even in small cities. He can conceive, however, of cases where it is impossible for economic reasons to pay the necessary salary. In these cases local men must be employed, and trained to do the work. Here the State Board of Health, or as in Illinois the State Water Survey, will find a very useful function. The State authorities could supervise the installation of a small, inexpensive laboratory equipment in small plants and give instruction to the local man in making the necessary water examinations. Whenever possible, however, young graduates of sanitary engineering schools should be employed; and such men are well worth their salary considering the saving in the economical adjustment of chemicals and fuel costs made possible by intelligent supervision. The greatest asset, however, to be credited to skilled operation is the saving of human life effected and the satisfaction of knowing that safe water is being furnished every day.